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in the brain of the following generation it certainly will change again as a creative power.

Bergson's philosophy proceeds from an *élan vital* of thought. This explains why it is saturated with the past and, as we may hope, pregnant with the future. The past with which it is saturated, however, is neither pragmatism nor any American nor English philosophy, for all these mean typical work of "understanding," while for Bergson philosophy begins where understanding ceases. The *élan vital* in Bergson's own philosophy is German and characteristic of the close affinity between German and French philosophy—an affinity which may be traced back all through the history of human thought. In former ages the influence of French thought on Germany preponderated over the influence of German thought on France. Since the beginning of the nineteenth century it is the influence of German thought on France which has preponderated because there was a feeling that the *élan vital* of German thought is creative and pregnant with a future. Never was its creative power developed with more splendor and force than in Henri Bergson's philosophy.

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HENRI POINCARÉ: OBITUARY.

On July 17, 1912, the world lost the great French mathematician whom Karl Weierstrass—one of the greatest mathematicians of the nineteenth century—when writing to Sophie Kowalevsky, specially singled out as one of the most eminent of the school of younger French mathematicians.¹

Jules Henri Poincaré was born at Nancy on April 29, 1854. He came of a family of which various members have risen to eminence. His father was professor in the Faculty of Medicine at Nancy, and wrote, among other works, on neurology at a time at which such researches were only pursued by a small number of scientific men. An uncle, Antoni Poincaré, wrote on meteorology; and, of his two sons, one is M. Raymond Poincaré, the present President of the Ministerial Council, and the other is M. Lucien Poincaré, who is Director of Secondary Education and Minister of Public Instruction. Henri Poincaré's only sister married M. Emile

¹ Cf. G. Mittag-Leffler, *Compte rendu du deuxième congrès international des mathématiciens tenu à Paris...1900*, Paris, 1902, pp. 145-148.

Boutroux, the distinguished philosopher, and their son, M. Pierre Boutroux, is a well-known mathematician.

Henri Poincaré was precocious, intellectually, and entered the Ecole Polytechnique in 1873, and in 1875 the School of Mines as engineering pupil; in 1879 he gained the degree of Doctor of Mathematical Sciences at the University of Paris; in the same year he joined the Service of Mines as engineer; in 1881 he became professor at the Faculty of Sciences in Paris; in 1887 he was elected a member of the Academy of Sciences; and in 1908 he was elected one of the forty "immortals" of the French Academy.

A biography of Poincaré and a bibliography of his works has been published by Ernest Lebon.² Poincaré's first original researches were in pure mathematics. In 1880 the Academy of Sciences proposed the theory of differential equations as the subject of the great prize. Poincaré sent in a sketchy memoir with the title "Non inultus premor"—that of the town of Nancy—which did not gain the prize but which Charles Hermite mentioned encouragingly in his report. From the beginning of 1881 the subject—the integration of certain linear differential equations—was developed with surprising genius and rapidity in a series of papers presented weekly to the Academy of Sciences. Weierstrass, who admired these papers so warmly, thought it a pity that Frenchmen published their discoveries in a succession of little papers. But surely the psychological interest is heightened by this mode of publication. We know that Poincaré worked almost subconsciously, and often had no idea of what he was going to discover. Gauss's motto was, *Pauca sed matura*, and even now almost every publication of his is an almost perfect and complete classic; and yet how greatly do we feel the need of some indication as to how these discoveries grew. Weierstrass reminds us in many respects of Gauss. His works, too, were never quickly published, and very many important things he found or views he held were either not published at all, or only long after he announced them, and then by his pupils. The case is different with Poincaré. One of the many reasons for which he will live is because he has made it possible for us to understand him as well as to admire him.

Poincaré's name is associated, for the pure mathematician, with the "Fuchsian," "Thetafuchsian," and "Zetafuchsian" functions. We now call them, after Felix Klein, "automorphic" functions. But we

² *Henri Poincaré: biographie, bibliographie analytique des écrits*; 2d ed., Paris, Gauthier-Villars, 1912 (collection "Savants du Jour").

can only refer to his other researches on the theory of functions and his allied work on the theory of numbers, and will now turn to his works on astronomy and physics.

Poincaré's investigations on the form taken by a gravitating mass of fluid in rotation (1885-1901) led him to interesting theories on the parting of the earth and moon and the formation of variable stars. His researches on the stability of the solar system, which consisted in the revision of Laplace's calculations and the carrying of them to a higher order of approximation, showed that Laplace's theory of 1784 was quite just. These and other results are contained in Poincaré's three volumes on the new methods of celestial mechanics.³ Here we must also refer to his works on the tides and on the problem of three bodies. On mathematical physics, Poincaré published many volumes of lectures given at the University of Paris and elsewhere on light, electricity—including the theory of Maxwell—capillarity, vortices, potential, thermodynamics, the theory of the conduction of heat, elasticity, and the theory of wireless telegraphy. Besides these, his lectures on the calculus of probabilities and on various subjects in celestial mechanics have been published.

Some very interesting psychological and physical details about Poincaré were published in 1900 by Dr. Toulouse as the second volume—the first was chiefly occupied by a study of Emile Zola—of his *Enquête medico-psychologique sur la supériorité intellectuelle*.⁴ The help given to the scientific answering of the question: "Le génie est-il une névrose?" by such studies is, of course, immense; but most of my readers are more concerned with the qualities associated with the great mathematical capacities of a man who took such a keen interest in questions on the border-line between mathematics and philosophy.⁵ It is impossible to read Dr. Toulouse's book without gaining a very vivid picture of the personality of Henri Poincaré. It is always deeply interesting to read authentic accounts of the methods of work of mathematicians, and for some years past, MM. H. Fehr, Th. Flournoy and E. Claparède have conducted an inquiry on this subject in the columns of *L'Enseignement mathématique*. Poincaré himself, in a well-known article published in 1908, has made some striking observations on his own process of mathematical discovery. And we must, I think, bear in mind, when

³ *Les Méthodes nouvelles de la Mécanique céleste*, Paris, 1892-1899.

⁴ *Henri Poincaré*; Paris, Ernest Flammarion.

⁵ Poincaré's work in this direction is well known to readers of *The Monist* by the translations of George Bruce Halsted.

reading Poincaré's articles on the logic of mathematics, that they are the work of a man who was primarily—perhaps almost exclusively—interested in the faculties of invention. When mathematical logicians asserted that the whole of mathematics follows by logical principles alone from concepts which can be logically defined and from the primitive propositions of logic alone, Poincaré and many other mathematicians objected that "intuition" was left out of account. There is a great likelihood that this is not really Kantianism in mathematics; only phrases make it seem so. Kant clearly recognized the distinction between the question as to whether a truth B is logically implied by a truth A and that as to whether B is discovered by a certain person who starts from the premise A alone and uses only purely logical considerations. The mathematical logicians do not deny to the seeker of truth either genius or the creative power—if such exist—of the artist; they are concerned with an epistemological question, and psychological objections are irrelevant there. The case is analogous to this: If someone were to point out that the properties of logarithms are simple consequences of the conception of one number as a power of another, he would not be confuted by the remark that Napier did not invent logarithms in that way; or again, it is not relevant to the student of Keats's poetry, as such, to know what porridge John Keats ate.

If this interpretation of the attitude of the "creative" mathematicians is correct, their position with respect to mathematical logic is easily explained. That the interpretation is correct seems supported by Poincaré's last controversial work on mathematical logic which he gave this year as a lecture to London University, and which has just been printed in *Scientia*.⁶ In the previous discussions on the use of the infinite in mathematics, in which Poincaré joined, each side kept on repeating the same arguments. There seems, in fact, a fundamental difference in mentality among mathematicians. Some, whom Poincaré called "pragmatists," believe that the infinite is derived from the finite, and all verification and all definition is performed with a finite number of words; others, the "Cantorians," believe that there are objects and truths which cannot be defined or demonstrated in a finite number of words. The Cantorians are realists and believe that the truth of a proposition does not depend on its verification by us. It is not difficult to place Poincaré, on the

⁶ "La Logique de l'infini," *Scientia (Rivista di Scienza)*, July, 1912, pp. 1-11.

grounds of some of his writings, among those whom he not inappropriately calls "pragmatists."

When Poincaré was five years old, he had a severe attack of diphtheria, and partial paralysis. All this made him rather weak for a long time, and perhaps was the origin of his lifelong clumsiness. Of his absence of mind, many stories are told. Once during a walk, he was suddenly surprised to find a wicker bird-cage in his hand. He had unconsciously removed it from a wayside stall.

As regards religion, at the moment of his first communion he was a believer; then belief left him gradually, and, from the age of eighteen he was a sceptic. In politics he was a republican; he held to the principle of personal property; he believed in political equality and the political rights of women,—but here he feared clerical influence.

In mathematics, he cannot be said to belong to any school. In a short life not without physical drawbacks, he has, by regular work, produced about 500 writings—some of them of the very first order.

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HENRI POINCARÉ: AN APPRECIATION.

The foremost of Frenchmen is no more. When Laplace was asked to name the greatest German mathematician he answered, "Pfaff." "But how about Gauss?" said the inquirer. "Ah," replied Laplace, "he is the greatest of all mathematicians." Similarly we might modify our first statement and declare that the foremost of all men is no more. For on July 17, having apparently recovered almost completely from a surgical operation undergone only a few days before, Henri Poincaré, while dressing himself in the morning, was suddenly smitten with an embolism and fell dying in the arms of his wife. While the delegates of learning from all quarters of the globe were assembling in London to celebrate the 250th anniversary of the Royal Society, instantly the brightest star in the galaxy of the sciences was eclipsed forever. The sad intelligence was at once flashed around the world, but the details as set forth in the Paris journals of the 18th are but lately at hand.

Commanding the homage and admiration of all, so generous, so pure-hearted, so noble-minded was Poincaré that he aroused the envy and jealousy of none. If "Freedom shrieked when Kosciusko fell," with far more propriety may universal Science, may Philosophy